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The Variant Concept of Transportation Disadvantaged: Evidence from Aydin, Turkey and Yamaga, Japan

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Abstract: Transportation disadvantaged groups, in the previous studies, are defined as those who are low income earners, family dependent, limited access to private motor vehicles and public transport services, and also those who oblige to spend relatively more time and money on their trips. Additionally those disable, young and elderly are considered among the natural groups of transportation disadvantaged. Although in general terms this definition seems correct, it is not specific enough to become a common universal definition that could apply to all urban contexts. This paper investigates whether travel difficulty perceptions vary and so does the definition of transportation disadvantaged in socio-culturally different urban contexts. For this investigation the paper undertakes a series of statistical analysis in the case study of Yamaga, Japan, and compares the findings with a previous case study, where the same methodology, hypothesis, and assumptions were utilized in a culturally and demographically different settlement of Aydin, Turkey. After comparing the findings observed in Aydin with the statistical analysis results of Yamaga, this paper reveals that there can be no explicitly detailed universal definition of transportation disadvantaged. The paper concludes by stating characteristics of transportation disadvantage is not globally identical, and policies and solutions that work in a locality may not show the same results in another socio-cultural context.

Keywords: Transportation disadvantaged, travel demand models, travel behavior, cluster analysis

Introduction

In a previous research undertaken by Duvarci and Yigitcanlar (2007), focusing on a case study in Aydin, Turkey, 'transportation disadvantaged' (TDA) groups were found mainly comprised of people who are disabled, young, elderly, low income earners, and those who have none or limited access to private motor vehicles, urban activities and public transport services. Duvarci and Yigitcanlar indicate that people who are spending relatively more time and money on their trips might be classified as TDA. However, some people who look like transport non-disadvantaged (TND) because they are spending less time and money due to less mobility or discomfort in public transport services might be also experiencing some sort of disadvantage. Uncertainties like these create obscurity especially when undertaking a comprehensive statistical analysis to determine TDA groups of a locality. This problem also causes ambiguity for the

statistical method used (i.e. regression, factor or cluster analysis) such as whether the disadvantaged should be measured on the basis of the outcome indicator variables of TDA (i.e. accessibility, mobility) or reason-based and disadvantage indicator variables of TDA (i.e. disability, car ownership).

The research reported in this paper is a follow-up study of Duvarci and Yigitcanlar's (2007) previous work on TDA in the case of Aydin, Turkey. Adding on to the previous study's findings, this research hypothesizes that 'the definition of TDA may change from one locality to another because of the different socio-cultural settings of these localities'. This is to say that perceptions under the influence of different social settings can be different, and this may have an immense effect on the definition of TDA. The aim of this paper, therefore, is to test this hypothesis in two socio-culturally distinctive case studies, which provides us an opportunity for a comparative study to reveal the socio-cultural differences in determining the characteristics of TDA.

Aydin, Turkey is selected as the first case study for the comparative study and the findings of this case are already published in an earlier issue of the *Journal of Urban Planning and Development* (Duvarci and Yigitcanlar, 2007). For the second case study, Yamaga, Japan is chosen on the basis of Japanese cultural context being one of the quite divergent cultures of the world in socio-cultural (i.e. a developed country with rigid and strict obedience to socio-cultural norms) and demographical (i.e. a super-aged society) terms, and also showing significant differences to Turkish context (i.e. a rapidly developing country with a resilient and super-young society). As the main statistical method of this comparative study, cluster analysis technique is used to determine both TDA and TND populations in two of the case studies. Similar to the Aydin study for the Yamaga study primary data for the analysis is also collected through a household travel survey.

Transportation Disadvantaged

Many cities around the world, particularly in North America and Australia, are plagued by the car-oriented suburbanization, which is a development characterized by low-density sprawl like development, big retailers replacing corner shops, doubled-up distances to major local activities, and removal of public transport lines from the poor districts (Lucas 2006, Yigitcanlar et al. 2008). In such development segregated view of the urban space can even have a larger responsibility in the resulting appearance of the disadvantage (Church et al. 2000). Poor local public transport system has a role in creating barriers for TDA or also so-called 'socially excluded' groups that have become more and more inaccessible (Hine and Mitchell 2003, Yigitcanlar et al. 2007). Hine and Grieco (2003) argue that combination of poor accessibility with low levels of mobility and

low levels of sociability intensifies TDA. In such circumstances what really matter is to provide more assistance to the most vulnerable groups, poor, elderly and disabled particularly in rapidly aging societies (Howe 1992, Lucas 2006).

Differences in the age structure of developed and developing countries (i.e. aging population of the developed countries and younger population of the developing countries) have a serious impact on the determination and perception of TDA. If TDA is not determined accurately, for example, elderly people can become more vulnerable and feel disadvantaged, insecure and less supported due to the additional physical disabilities they possess. Another important trend in the aging societies, which affects the overall view of TDA, is senior citizens' driving behaviors (e.g. reduced driving skills, acuity problems). This means an increased safety risk when older people driving, particularly in places with high elderly people concentrations (Davidse 2006). Yet, for most of these people, there is no alternative travel modes available unless special paratransit options are provided. Contrary, due to low level income and high young population concentration, most of the developing country TDA groups are heavily public transport dependent. Public transport dependency of TDA is a widely discussed topic in the literature in both developed and developing country contexts (i.e. Litman and Colman 2001, Hine and Grieco 2003).

In recent years a number of studies have been conducted in order to determine TDA population more accurately. For example, Duvarci and Yigitcanlar's study (2007) sought integration of TDA analysis with mainstream travel demand models by employing perceptional data, in which TDA could neatly be determined through a cluster analysis focusing on community travel conditions in Aydin, Turkey. Some UK-based studies used accessibility measures to determine TDA (Church et al. 2000). For instance, Schmocker et al. (2005) determined the trip making characteristics of elderly and disabled for four key trip purposes by analyzing the London Area Travel Survey (2001). Wu and Hine (2003) provided a classification on TDA by deprivation domains of income, employment, health, disability, education, geographical access to services, social environment, and housing. Church et al. (2000) defined seven basic TDA types: physical, geographical, exclusion from facilities, and economic-, time-, fear- and space-based exclusions. Despite the growing literature and interest on the recent call of governmental policie on social exclusion, such as in the UK, there are still both methodological and conceptual problems in tackling the TDA issue comprehensively.

One of these problems is almost all of the widely accepted parameters in measuring TDA not determining TDA populations accurately under every socio-cultural contexts. For instance,

sometimes TDA may spend less time and money on their trips due to their low mobility level. Likewise, travel is assumed to be an impediment, which is true especially for work trips, and a cost to be reduced whenever possible (Salomon and Mokhtarian 1998, Ory and Mokhtarian 2005). Similarly increasing leisure activities and the time allowed to such trips may not be considered costly, thus, the accurate modeling of leisure trips becomes more critical especially for TDA groups. Thus, it is useful if TDA groups are determined for each trip purposes (e.g. journey to work, school, shopping, leisure). Also inequity arises between people who have and who have not own or access to a car. Yet, the cost of driving in some developing countries (i.e. in Turkey) is quite high due to higher fuel prices and ever-increasing congestion, thus owning a car does not necessarily make them TND, which is not the case in the U.S. or Australia, where driving is more affordable due to lower fuel prices, cheaper cars and poor and relatively costly public transport services. Additionally, peak hour congestion is many times perceived as the biggest problem, but the perception is relative and endurance to the congestion changes from one culture to another and from metropolitan areas to remote settlements. Income levels also may have different implications on difficulty perceptions. Moreover, even disable or elderly may feel non-disadvantaged, if they are provided with easy accessibility and mobility options.

TDA is a dynamic and multidimensional issue involving physical, temporal, economical, spatial, and psychological dimensions (Hine and Mitchell 2001, Schonfelder and Axhausen 2003). Because of the multi-dimensionality of TDA (i.e. accessibility, mobility, cost, comfort, convenience) serious measurement and level of analysis difficulties arise (Yigitcanlar et al. 2007). While most of the recent research managed to locate the problem and enriched discussion and convergence successfully, they have failed to determine TDA accurately. As Cervero and Mason (1998) pointed out because of the cultural significance of the issue, travel behaviors may show variety in different cultures and even from one TDA group to another. Thus, determination of TDA can be highly place, culture and context dependent.

Cross Cultural Comparative Transportation Disadvantage Analysis

This research undertakes a comparative cross-cultural study of two urban settlements (Aydin and Yamaga) and uses a methodology based on Duvarci and Yigitcanlar's (2007) work. Similar to Duvarci and Yigitcanlar's previous work this research also uses a cluster analysis technique to clearly separate the population into two clusters (i.e. TDA and TND) not only based on a single variable, but many. For both of the case studies, first, a generic TDA group is defined. Secondly, the distance or membership degrees of surveyed individuals, considering their demographic, socio-economic and travel characteristics, to this group's delimitation boundary are measured. Thirdly, as a result a metric gauge is obtained to be used to determine TDA accurately. Lastly, the

results of both case study findings are compared and discussed.

The Case of Aydin, Turkey

The Aydin study was undertaken in 2005 and the findings of this study were reported in Duvarci and Yigitcanlar's (2007) research paper. The generic TDA definition developed for the case study of Aydin was based on the factors of: income, car availability, accessibility, demographic characteristics (i.e. age, gender, disability, family size and structure) and the existing transportation service and facilities (i.e. frequency and quality). The variables employed while determining TDA in the Aydin study are summarized in Table 1.

[INSERT TABLE 1]

The Aydin study found that the model developed for this study is capable of precisely determining the trips of the TDA by multivariate modeling based on the knowledge derived from the differences between the TDA and TND. The pilot study revealed that travel patterns can be accurately determined through the steps of this model, the TDA concentrations can be geographically determined, and the degrees and the types of disadvantages can be defined straightforwardly (Duvarci and Yigitcanlar 2007).

The Case of Yamaga, Japan

Yamaga is a town located within the Kumamoto prefecture, for about 25 km north of the Kumamoto city in Kyushu Island of Japan, with a population of almost 60,000 people, a total area of about 300 sq.km and a density of around 200 persons/sq.km. Currently females constitute 53 percent of the population, and average household size is 2.8 with a slow annual gradual decrease. Yamaga is one of the regional cultural and natural attraction points of the Kumamoto prefecture known by its famous traditional theatres and various hot spring baths. Yamaga is chosen as a case study for several reasons. Firstly, for being a content town very close to Kumamoto University, and having quite a large number of elderly and TDA populations. Secondly, for the suitability of examining TDA groups in a locality with different socio-cultural characteristics than Aydin. Lastly, Yamaga is chosen as a case study for the opportunity to use a recently conducted household travel survey data (2008).

Generally in Japan and particularly in Yamaga most of the people do not suffer adversely from the negative impacts of transportation system (e.g. poor public transport services, low accessibility levels or inefficient transportation infrastructure). The major problem is the inadequate space allocation for pedestrians, cyclists and even for cars (e.g. narrowness or

absence of streets, footpaths, bikeways and parking lots). Interviews undertaken with the residents of Yamaga reveal that most of the population is happy with what is provided, and seems to be not bothered much by the aforementioned inefficiencies. This is probably due to cultural reasons (e.g. being non-contentious, respectful and patient people), which is an indication of the TDA concept being perceived significantly different in Yamaga than Aydin.

Japan is a 'super-aging' society, with a current population aged 65 and over comprising 21 percent, and becoming 25 percent of the population in 2013, which means about one-third of the society will be over 75 in 2050 (NIPSS 2007). Besides being a super-aging population, Yamaga has a strong economy and technology driven way of life, and literally does not have much transportation infrastructure and service problems as observed in Aydin. Many public transport facilities are provided for elderly and disabled. In most places, traffic is guided through intelligent transport systems, and public transport has always a priority over private motor vehicles Yamaga's major transportation related problem mainly comes from the lack of space, which results in narrow roads without separate bike lanes. However, cultural norms in Yamaga do not allow intolerance or showing explicit anxiety, and as being patience, understanding and respectful society, transport difficulty perceptions in Yamaga are significantly different than Aydin. Such strong cultural qualities and peculiarities make Yamaga a very interesting case study to compare with our previous study of Aydin.

Data

Secondary data is collected from the Transport Department, Census Bureau and Kumamoto University. Primary data for the Yamaga case study is collected by undertaking semi-structured interviews and a household travel survey. Interviews are conducted with experts and residents in order to have a broad understanding in how TDA is generally perceived in Yamaga. Similar to Aydin case a household travel survey is also undertaken in order to collect data to run in the spatial analysis model to determine TDA populations. Out of 655 household surveys 335 of them had reliable responses that meets the sampling ratio target of 1 percent for a disaggregate data analysis in Yamaga. Around 45 percent of the surveyed population were males and 55 percent of females. Nearly 6 percent of the population were under the age of 18, 65 percent of them were in the age group between 18 and 65, 19 percent were in the age group between 65 and 75, and 10 percent of were over 75. Survey data presents the typical profile of Japanese demographic structure, pointing a 'super-aging' society (29% of Yamaga residents being over 65) where 75 percent of them had a valid driving license. Salient travel characteristics of Yamaga in nine categories of trip purposes and their differences by mode choice, which have a significant impact on the definition of being disadvantaged, are presented in Table 2. In terms of modal choice, car

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use together with the mode of car passengers were dominant in Yamaga, and public transport and taxi modes were negligible for such a small-size town, while not surprisingly walking and cycling modes were quite popular. The use of public transport and walking and cycling modes seemed to show variations in different trip purposes. Interestingly, public transport mode was the preferred mode for both commuting and social-recreational activities, while it was not the case for business, shopping and health-related trips. Similarly, there was a big difference observed between daily and weekly shopping trips by walking and cycling modes, while walking and cycling were not the preferred modes for leisure and sightseeing trips. Travel time also fluctuated by the purpose of the trip.

[INSERT TABLE 2]

Surveyed household size was around 2.2 of which only seven years and older were surveyed. Trip rates for each day of the week were observed as: Monday 1.25, Tuesday 1.20, Wednesday 1.25, Thursday 1.23, Friday 1.25, Saturday 1.32 and Sunday 1.22. The overall distance traveled and travel time averages of all trip purposes were 21.1 km. and 35.2 minutes respectively, yet they were not weighed with the trip frequencies for each trip purpose. The following number of individual observations were evaluated for each trip purposes: 81 business trips (81/335=24% of all trips), 106 commuting trips (31%), 162 doctor's surgery trips (48%), 87 hospital trips (26%), 182 daily shopping trips (54%), 155 weekly shopping trips (46%), 102 leisure trips (30%), 152 social visit trips (45)%, and 98 sightseeing trips (29%). Among all trip purposes, shopping, social and recreational trips constituted more than half (61%) of all trips (Figure 1).

[INSERT FIGURE 1]

Methodology

Since the Yamaga study aims to examine whether the findings of the Aydin study is applicable elsewhere and the structure of the TDA definition is variant from one culture to another, the Yamaga study adopts the same methodology of the Aydin study, which is a sophisticated clustering technique. Cluster analysis is a statistical technique that is used for grouping similar cases (i.e. TDA and TND). Clustering algorithms are methods to divide a set of observations into groups so that the members of the same groups are more similar than members of different groups (Ripley 1999, Hauser et al. 2000). Cluster analysis are used to divide the population on the basis of the nearest neighbor rule. All variables and the value scales are assumed to have equal weights in the clustering process and all variable values are assumed to be scaled so the downward values representing TDA and the upward values TND. Cluster center values mean the

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total central value of all values measured, in Euclidian terms, per each cluster for all variables and concerning all values taken in the clustering process. Thus, the distance between the two cluster values shows the severity of disparity between the clusters and the severity of being disadvantaged. This method uses K-means type clustering.

As the Aydin study enabled a clear definition of two distinct clusters by K-means cluster analysis with a positive sign direction assumptions of variables, the Yamaga study checks out the same method whether the same technique and assumptions are applicable in a culturally different setting. Thus, same data to the Aydin study is collected and clustered for the Yamaga study, and the results are analyzed whether the same type (K-means) of clustering yields a clearly defined TDA. Additionally different types of trip purposes are also compared.

The clustering method is analyzed with SPSS software and no threshold values are introduced. Before the cluster analysis, the value standardization process is preceded, where all variables are converted to rate values between 0 and 1. This is realized by the sigmoid function for non-categorical data. The usual conversion function for variables is undertaken as below:

$z = (x_i - x_{min})/ (x_{min} - x_{max})$

Where z , is the standardized value between 0 and 1,

x_i is any observation value to be standardized, and,

$x_{min} - x_{max}$ is the difference between minimum and maximum values in the dataset of the variable.

Some categorical or likert scale value standardizations (i.e. car ownership, mode captivity, trip frequency, satisfaction and comfort-safety variables) require no sigmoid function, but a direct conversion from categorical value assignment. A conversion example of weekly trip frequency is shown below:

$z = 0.01$ (for 0 can not be used)	if t (trip rate) = 0 (category 4)
$z = 0.33$	if t = 1 trip in a week (category 3)
$z = 0.67$	if t = 2 or 3 trips in a week (category 2)
$z = 1$	if t = at least 1 trip everyday (category 1)

Different from others, mode captivity index value determination is prepared on the basis of all trip purposes, rather than calculating each trip purpose separately. An example is shown below:

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$z = u_p / u_k$

Where u_p is the choice of public modes (public transport, walking and cycling options all together) for all purposes of a person's weekly trips, and u_k is the total of all modes used for all trip purposes.

Positive utility sign assumption setting is a key step before the clustering process commences. Therefore, in a sound multivariate clustering procedure it is important to decide which variables to stand a positive meaning when their observation values increase, and which others to position negative. For positive direction, negative variables should be converted to positive simply by subtracting the values from 1. In the Yamaga study, the same directions were accepted as defined in the Aydin study for the same variables.

Before the clustering process, as an important step, 335 observations are analyzed for each trip purposes. Only those having trips clearly for the purpose concerned (e.g. 106 observations are used for commuting trips) are taken into evaluation for one cluster analysis, then other cluster analyses are conducted consecutively for the other trip purposes (e.g. sightseeing trips).

Cluster analysis accommodates a number of variables to identify disadvantage population, and in a comparative study it is key to use the same variables. The Yamaga study, therefore, uses eight of the 12 variables of the Aydin study in determining TDA, which is necessary to see whether different local and cultural settings make a difference in identifying TDA populations (Table 3). However, as the literature suggests criteria or variables used in one place may not necessarily be applicable to elsewhere because of the specific socio-cultural and economic conditions of other communities and places. Therefore, socio-demographic indicators of the Aydin and Yamaga studies are not taken as variables in measuring disadvantages, they are considered as the 'dimensions' of TDA, rather than the core factors. This is to say only eight variables are used to compare both case studies. TDA was defined as a multi-faceted term in the Aydin study, meaning that TDA can be determined by entering simultaneous input of various measurable criteria in a cluster analysis model. The details of the Yamaga case study and the methodology are presented in the next section (for more information on the Aydin case study see Duvarci and Yigitcanlar 2007).

[INSERT TABLE 3]

In the cluster center results, those downward values (approaching to 0) indicate disadvantage. For example, the values of family dependence as the total number of older (above 65) and

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younger (below 7) people among the family members increase the family dependency that means a clear disadvantage, and is currently an upward value when these indices appear in a household. Therefore, the value needs to be converted to upward utility values (approaching to 1) by subtracting the value from 1. This kind of conversion is necessary for standardization of the values for a sound clustering process. This procedure is undertaken for six variables, which means getting closer to a value of 1 indicates a non-disadvantage and getting closer to 0 a disadvantage. The remaining variables of comfort and satisfaction related variable results are already upward utility values, therefore, there was no need for a conversion.

As shown in the cluster center results of the Aydin study in Table 4, the variable cluster center values were in accordance with the utility sign assumption setting: low values appeared in the left and high values in the right hand side (in a scale bar of 0 to 1). Thus, in the Yamaga study, similar assumptions for each variable are made as below:

[INSERT TABLE 4]

Family dependence: Family dependence data was showing a downward value for the Yamaga residents by approaching to 0, indicating disadvantage in other words TDA concentration. As Fujii et al. (1999) state elderly and young people potentially create a mobility dependence on the other members of the family, and lower the level of mobility. Therefore, the variable values for family dependence are required to be subtracted from 1 to convert them into upward values to indicate non-disadvantage.

$$z_i = 1 - ((n_o + n_y)/n_h)$$

Where, z_i is the scaled and sign converted value for i^{th} person, n_o is the number of elderly (above 65 years old), n_y is the number of young (below 7 years old), and n_h is the household size.

Car availability: Those who do not have access to a private motor vehicle are most likely the disadvantaged ones. Therefore, it is expected that first cluster's center values to be greater than the second cluster's center results. Categorical data values are converted as below:

$z_i = 1 - x^s_i$ $x^s_i = 0.16$, if $x_i = 1$ (survey data value for having a car each)
$x^s_i = 0.5$, if $x_i = 2$ (survey data value for having a car in the family)
$x^s_i = 0.83$, if $x_i = 3$ (survey data value for not having a car)

Where x^s_i is the scaled data value, while x_i is the raw survey data (categorical value)

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Time: Travel time is generally accepted as an impediment factor, though it is not necessarily true for leisure trips. Therefore, the value obtained from the raw survey data is subtracted from 1 to be converted into an upward value. Open-ended values are converted as below:

$z_i = 1 - x^s_i$ $\quad x^s_i = (x_i - 1)/(90 - 1)$ $\quad (x_{max}$ is taken as 90 min.)

Distance: Similar to travel time distance traveled is also considered to be an impediment, but in some cases it is also an indicator of being non-disadvantaged. This causes a problem in defining the direction sign in trip distances. Hence, obtained data results are subtracted from 1. Open-end values are converted as below:

$z_i = 1 - x^s_i$ $\quad x^s_i = (x_i - 1)/(50 - 1)$ $\quad (x_{max}$ is taken as 50 km.)

Mode captivity: Mode captivity values do not need any conversion since they already have values close to 1.

$z_i = (n_p / n_a)$

Where n_p is the total of all public modes chosen by trip purposes, and n_a is the number of all modes chosen. If private modes are chosen for all trip purposes, then the value of 0.01 is assigned instead of 0 for the ease of calculation.

Trip rate: Number of trips or average trip frequency throughout the week does not need positive sign conversion, since it already has higher values. Categorical data values are converted as below:

$x^s_i = 0.01$ (instead of 0)	if $x_i = 0$ (no trip)
$x^s_i = 0.33$	if $x_i = 2$
$x^s_i = 0.67$	if $x_i = 3$
$x^s_i = 1$	if x_i is greater than 3

Satisfaction: General transportation system satisfaction that a person perceives before commencing the travel, such as convenience, reliability, system quality, requires conversion. Categorical data values are converted as below:

$x^s_i = 0.0834$ $\quad$ if $x_i = 1$ $\quad$ (highly dissatisfied)

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$x^s_i = 0.251$ if $x_i = 2$
$x^s_i = 0.417$ if $x_i = 3$
$x^s_i = 0.583$ if $x_i = 4$
$x^s_i = 0.75$ if $x_i = 5$
$x^s_i = 0.917$ if $x_i = 6$ (highly satisfied)

Where x^s_i values are the mean values of each category between 0 and 1.

Comfort: Travel comfort perception usually refers to the comfort and quality levels of in-vehicle and travel conditions. Similar to transportation system satisfaction, travel comfort requires conversion. Standardization process of the values for comfort is identical to the transportation system satisfaction's process.

In the Yamaga study, four basic trip purposes, each having a major (i.e. hospital trips) and a minor (i.e. doctor's surgery trips) activities, are analyzed: work-related trips consist of commuting and business trips; health-related trips consist of doctor's surgery and hospital trips; shopping-related trips consist of daily and weekly shopping trips; and recreational trips consist of leisure, social visit and sightseeing trips.

Aydin study accommodated 12 variables (see Table 1) while Yamaga study only employed eight variables to determine TDA populations. All of the variables used in the Yamaga study are identical to the equivalent variables of the Aydin study and only these eight variables are used for the comparison. For example, 'Family dependence' variable of the Yamaga study is same as the 'Fam.Dep' variable of the Aydin study. Similarly 'Car availability' variable of Yamaga is same as 'Veh.Ava' of Aydin and so on. Travel time impediment sub-variable of Aydin's cumulative impediment variable and Yamaga's travel time variable are equivalent variables. In the same way, travel distance impediment sub-variable of Aydin's cumulative impediment variable and Yamaga's travel distance variable are equivalent variables. Only 'Comfort' variable of Yamaga as it includes both public transport and private motor vehicle comfort dimensions is equivalent of the two variables of Aydin, 'Com.Pub' and 'Com.Veh'. Four of the variables of the Aydin study have not been adopted by the Yamaga study, 'Acc.lev', 'Edu.Lev', 'Inc.Lev' and 'Sch.Trp' for the reasons explained before (see Table 3).

Variables of the analysis worked efficiently in order to determine the disadvantaged cluster. For example, interdependence of household members ('Fam.Dep' in the Yamaga study or 'Family dependence' in the Aydin study) to each other due to the demographic status (having children, elderly and disable) is very critical in organizing daily trips. The daily travel pattern of a family

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becomes severely dependent on each other, especially children depending on their parents not only from the economic angle but from the mobility. This is clearly verified in the Srinavasan and Ferreira's study (2002) scrutinizing transport survey analysis of almost 4,000 households in Boston. According to Srinavasan and Ferreira children and the number of workers in a household do affect the mode choice.

Generalized cost is the most important determinant for TDA, and usually taken as a key factor with distance (accessibility) to a car park (for car users) or a bus-stop (for public transport users). According to 2007 National Center for Transit Research, there are huge differences in distance according to the differences in urban size, ethnicity, income and car ownership, which are key to determine TDA groups. For example, only less than 40 percent of Americans have access to public transport services by walking from home (within a quarter mile) that impacts their modal choice significantly. Time cost is generally the summation of access-to-a-stop (or a car park) while walking, waiting time at a bus-stop, and travel duration (additionally access time to destination). In the Aydin study, the generalized cost (Cum.Imp) did not come up as an effective divider between the two clusters, so did mode and peak captivity (with an emphasis on disable or elderly). Public transport and peak captivity may be added to disadvantage variables because one's dependency on a single mode of transportation and travel time affects their travel quality. Peak hour congestion affects both public transport users and car drivers adversely but not in equal shares (Downs 1992). Personal disabilities and weaknesses are the magnifiers of the level of disadvantages of those peoples' travel experiences rather than separate factors per se. Demographic dimension also adds onto this as the number of disable and elderly people are increasing throughout almost all nations (Blaser 1996, Deakin 2003).

When the results of the clustering analysis of the Aydin study were examined (see Table 4), it can be clearly seen that disadvantaged cluster center values are lower than non-disadvantaged cluster's, with an exception of cumulative impediment variable (Cum.Imp) showing generalized travel costs of individuals. That means contrary to what is hypothesized TDA group is not necessarily disadvantaged in all categories. Only for three variables big differences were observed: vehicle availability (Veh.Ava), income (Inc.Lev), and education level (Edu.Lev). For the rest, the difference between the two cluster center values was so negligible, and as hypothesized disadvantaged cluster had lower center values, which shows the robustness of the methodology.

Comparison of the Aydin and Yamaga Case Study Findings

Cluster center results of the Aydin study show that the second cluster center values compared to

the first cluster became almost always greater with only one exception of cumulative impediment variable (see Table 4). Especially, car availability and income, accessibility and education levels play a crucial role in the formation of two distinct clusters (Cluster 1 and Cluster 2). That is to say, there is a clear distinction between these two clusters, except what was obtained from the obligatory trips (i.e. journey to work and school) in the Aydin case.

Contrary to the case of Aydin, the Yamaga case findings provide very different cluster center results, which is an unclear distinction between the two clusters. However in Yamaga if the utility directions for each variable were differently hypothesized, then, the results may have provide two distinct clusters. But, under either circumstance profiles of the TDA would be different for Aydin and Yamaga because of their contradictory socio-cultural contexts. When the findings listed in Tables 5, 6, 7 and 8 are analyzed, sometimes cluster 1 and sometimes cluster 2 behave like TDA depending on the particular variable's cluster center results. In these Tables, bold figures show higher values compared to the other cluster's values, and underlined figures indicate distinctly separated values. The behavioral shift between the two clusters is a 'polar shift', and when the polar shift occurs, it creates ambiguity and does not clearly explicate distinctly separated clusters (i.e. TDA and TND). Even when the obligatory trips of Yamaga are compared with Aydin's obligatory trips (i.e. journey to work and school), no resemblance between the two could be observed.

[INSERT TABLE 5]

[INSERT TABLE 6]

[INSERT TABLE 7]

[INSERT TABLE 8]

The following observations and findings from the Aydin and Yamaga case studies are worth mentioning:

- In daily shopping and work-related trips, especially in cluster's center results of mode captivity and car availability variables, vast differences are observed. A polar shift is occurred between the two clusters (i.e. higher values appeared in the second cluster).
- Those who are dependent on public modes are found to be more disadvantaged in work, shopping and school trips. However, disadvantages can vary by trip purposes. For

example disadvantage from mode captivity appears in the first cluster for work-related trips, while same kind of disadvantage appears in the second cluster for shopping-related trips.

- Mode captivity variable is dominant in distinguishing two clusters, but many times polar shifting of the clusters is necessary.
- Satisfaction variable is the indicator where vast differences are measured in work-related trips.
- In health-related trips, equivocally family dependence and car availability variables are the main reasons for the large differences.
- Family dependence requires scrutinized trip planning at the household level, and plays a crucial role in timely access to health facilities. Access to a car is considered as a better option for urgent health-related trips.
- In social and leisure trips mode captivity plays a key role. Polar shifting of the clusters is necessary for the social visits and leisure trips when using satisfaction, comfort and mode activity variables.
- Variables, such as trip rate in hospital and sightseeing trips, and time and distance in commuting trips, are not significant dividers but only show discernibly differences between the two clusters.

Aydin's clustering was only undertaken for the work trips and hence, only compared with work-related trips of Yamaga. Cluster center values for the eight variables for Aydin and Yamaga show large variations (see Table 4 and 5). Especially mode captivity of the Yamaga study seems to be an important divider between TDA and TND, while this was not the case in Aydin. In the Aydin study comfort variables of Com.Pub and Com.Veh and their TDA cluster center values did not differ clearly from TND, while this is opposite for the Yamaga study. There is not much difference in all impediment variables (Cum.Imp, Mop.Imp and Ptr.Imp) between the two clusters in Aydin, while there are considerable differences in the cases of time and distance, mode captivity and satisfaction in Yamaga. The clustering results of car availability show similar significant differences between the two clusters in both Aydin and Yamaga.

Contrary to Aydin, in Yamaga people feel more disadvantaged while driving a car than using a public transport. This is mainly because public modes are more convenient for work-related trips in Yamaga. Generally passengers in Yamaga find public modes much safer, less costly and more comfortable. However, it is a disadvantage not having access to a car in health-related and shopping trips. In weekly shopping trips, there is a clear distinction between the two clusters.

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The results of the research reported in this paper reveal that the hypothesis is verified as the clustering findings in the Yamaga study are quite different than the findings of the Aydin study. In contrast to Yamaga, in Aydin two clusters (TDA and TND) were determined discretely. Although in both cases mostly the same variables were used, findings for the Yamaga study do not indicate significantly separated two clusters and, thus, a clear determination of a TDA group was not possible. TDA seems so variable, hence, it cannot be said that TDA can clearly be determined in every socio-cultural context by using the same variables and methodology since the observed TDA definitions needed to be local case specific as proved in this cross-cultural comparative study.

Conclusion

The literature indicates that it is not possible to develop and implement policies to solve acute disadvantage problems, unless TDA groups are clearly determined. This paper, therefore, examined a statistical model used to determine TDA in Aydin whether the model is capable of determining TDA in a different socio-cultural environment of Yamaga. Clustering results of the Yamaga study did not yield a distinctly separated TDA and TND cluster structure as in the case of Aydin. Additionally, different than the Aydin case, the variations of different trip purposes for Yamaga are investigated, but, no clear conclusions could be drawn from this investigation. The research found that the definition of TDA is quite different in the case of Yamaga than Aydin. The results of the comparative study confirm that perceptions under the influence of dissimilar socio-cultural settings can be diverse, and this may affect the methods and variables accommodated to determine TDA in different localities. This is to say it is very difficult to define TDA clearly by using the exact methodology in every socio-cultural context. This research also proves Cervero and Mason's (1998) claim that characteristics of transportation disadvantage is not globally identical, and policies and solutions that work in a locality may not show the same results in another socio-cultural context. This is to say characteristics of TDA is not globally identical, and tailored policies and solutions are necessary for different socio-cultural contexts. However, the methodology developed in this paper based on cluster analysis is found to be a suitable method to distinctively divide the population into TDA and TND, of course if appropriate variables are carefully selected for each socio-culturally different case.

The research findings point out the necessity for technicians and policy-makers to be aware of the socio-cultural differences when determining TDA and developing policies to overcome disadvantages. Therefore, it is essential to define a generic universal set of variables and criteria in determining TDA globally, albeit its socio-cultural nature. This may help the standardization of cross-cultural generic TDA definition. Developing a broad general definition without

culture-sensitive parameters of TDA would be of benefit to local authorities as a template to be customized for local needs by integrating local socio-cultural parameters. Such customized TDA models would be useful in supporting urban and transport planning and development, where TDA-integrated policy-making is critical to provide equity in the provision of public transport infrastructure and services. In other words, local governments and transport authorities will highly benefit from such customized, local socio-cultural aspects embedded and TDA-sensitive models in deploying most relevant policy measures for the community. Therefore, further research is currently being conducted by the authors to develop generic variables to determine broad TDA communities in different socio-cultural contexts. At the same time we acknowledge that in order to specifically pinpoint TDA clusters case specific variables need to be defined for each locality under scrutiny. Another case study, in Brisbane, Australia, is being investigated to test the effectiveness of generic as well as locally sensitive variables. We are also aware of the importance of improving the statistical methodology for determining TDA accurately by particularly considering the inclusion of factor analysis technique to the methodology.

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Figure Captions

Figure 1. Percentage shares of major trip purposes in total trips in Yamaga

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Tables and Captions

Table 1. Variables of the Aydin study (Duvarci and Yigitcanlar, 2007)

Category	Category name	Notes
Acc.Lev	Accessibility level	Determines people with poor accessibility opportunities to basic urban service and amenities
Com.Pub	Comfort level of public transport	Determines passenger density and comfort conditions of public transport services
Com.Veh	Comfort level of private motor vehicle	Determines private motor vehicle comfort levels
Cum.Imp	Cumulative impediment	Determines the cumulative effect of basic travel impedance elements – This variable has two sub variables of travel time impediment (Imp.Tim) and travel distance impediment (Imp.Dis)
Edu.Lev	Education level	Determines household education levels that reflect individual trip generation
Fam.Dep	Economic dependency	Determines economic dependency levels of the family members that impact trip generation
Inc.Lev	Income level	Determines individual income levels that impact trip generation
Mop.Imp	Mode and peak impediment	Determines combined effects of mode and peak captivity together with an emphasis on the disable population
Ptr.Imp	Public transport impediment	Determines public transport service, both quality and quantity, conditions
Sch.Trp	Journey to school	Determines travel quality and conditions of students to and from school
Veh.Ava	Motor vehicle availability	Determines the number of people with no access to motor vehicles
Trp.Fre	Trip frequency	Determines the frequency of all trip types, i.e. commuting, education, leisure, health and social.

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Table 2. Salient travel characteristics of Yamaga by trip types

trip type / travel time, distance and mode	commuting	business	daily shopping	weekly shopping	doctor's surgery	hospital	social visits	leisure	sight seeing
time (min)	21.2	25.5	11.8	35.25	13.47	59	23.1	52.2	78.38
distance (km)	9.67	15.6	4.87	18.5	6.07	30.4	11.78	29.52	63.47
mode (%) car driver	74	87	78.9	81.6	74.6	81.2	79.2	80.1	74.8
mode (%) car passenger	5	5.3	9	13.5	10	15	9.1	12.5	16.9
mode (%) taxi	1.2	0	0	0	1.2	0	1	0	2.9
mode (%) public transport	3.7	0	0	3.3	0	2.5	2.4	5.9	4.7
mode (%) walking & cycling	15.7	7.5	12	1	13.7	0	8.3	0	0

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Table 3. Variables of the Aydin and Yamaga studies

Variables of the Aydin Study	Variables of the Yamaga Study	Notes
Fam.Dep	**Family dependence**	Aydin and Yamaga studies employ the same family dependence variables.
Veh.Ava	**Car availability**	Aydin and Yamaga studies employ the same car availability variables.
Mop.Imp	**Mode captivity**	Aydin and Yamaga studies employ the same mode captivity variables.
Ptr.Imp	**Satisfaction**	Aydin and Yamaga studies employ the same trip satisfaction variables.
Trp.Fre	**Trip rate**	Aydin and Yamaga studies employ the same trip rate variables.
Cum.Imp (Imp.Tim)	**Time**	Travel time impediment sub-variable of Aydin's cumulative impediment variable and Yamaga's travel time variable are equivalent variables.
Cum.Imp (Imp.Dis)	**Distance**	Travel distance impediment sub-variable of Aydin's cumulative impediment variable and Yamaga's travel distance variable are equivalent variables.
Com.Pub & Com.Veh	**Comfort**	As the 'Comfort' variable of the Yamaga Study concerns of both public transport 'Com.Pub' and private motor vehicle 'Com.Veh' comfort levels, both Aydin and Yamaga studies employ the same travel comfort variables.
Acc.Lev	**-**	A variable indicating accessibility levels has not been employed in the Yamaga Study.
Edu.Lev	**-**	A variable indicating education levels has not been accommodated in the Yamaga Study.
Inc.Lev	**-**	A variable indicating income levels has not been accommodated in the Yamaga Study.
Sch.Trp	**-**	A variable indicating school trip levels has not been accommodated in the Yamaga Study.

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Table 4. Variable cluster center values of the Aydin study (Duvarci and Yigitcanlar, 2007)

	Cluster's center values	
	1	2
Acc.Lev	45.88	**50.48**
Com.Pub	68.17	**68.47**
Com.Veh	37.59	**38.41**
Cum.Imp	**86.51**	85.05
Fam.Dep	58.53	**64.81**
Edu.Lev	36.68	**43.41**
Inc.Lev	9.43	**18.63**
Mop.Imp	73.40	**73.94**
Ptr.Imp	95.89	**96.07**
Sch.Trp	63.78	**69.70**
Veh.Ava	6.37	**54.73**
Trp.Fre	29.69	**41.11**

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Table 5. Yamaga work-related trips cluster center results

	business trip clusters		commuting trip clusters	
	1	2	1	2
Family dependence	**.76**	.43	.71	**.72**
Car availability	**.77**	.60	**.77**	.63
Time	.83	**.92**	.60	**.91**
Distance	.85	**.95**	.67	**.94**
Mode captivity	**.96**	.70	**.88**	.73
Trip rate	.65	**.82**	.92	**.94**
Satisfaction	**.47**	.29	**.50**	.17
Comfort	.60	**.79**	**.65**	.24

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Table 6. Yamaga shopping-related trips cluster center results

	local shopping trip clusters		weekly shopping trip clusters	
	1	2	1	2
Family dependence	.39	**.64**	.60	.60
Car availability	.42	**.75**	.47	**.74**
Time	**.90**	.89	.67	**.72**
Distance	**.96**	.89	.76	**.78**
Mode captivity	.16	**.93**	.12	**.93**
Trip rate	**.75**	.74	.45	**.54**
Satisfaction	.34	**.39**	.57	.57
Comfort	**.72**	.70	**.64**	.55

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Table 7. Yamaga health-related trips cluster center results

	doctor surgery trip clusters		hospital trip clusters	
	1	2	1	2
Family dependence	.38	**.62**	.34	**.81**
Car availability	.41	**.75**	.59	**.78**
Time	**.90**	.86	.51	**.56**
Distance	**.93**	.85	.48	**.54**
Mode captivity	.13	**.92**	**.86**	.79
Trip rate	**.48**	.42	**.33**	.14
Satisfaction	.29	**.38**	**.49**	.38
Comfort	**.71**	.62	**.49**	.39

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Table 8. Yamaga leisure-related trips cluster center results

	leisure trip clusters		social-visit trip clusters		sightseeing trip clusters	
	1	2	1	2	1	2
Family dependence	**.64**	.50	.47	**.65**	.63	**.65**
Car availability	**.74**	.43	.42	**.75**	**.73**	.54
Time	.65	**.74**	.83	**.85**	**.59**	.56
Distance	.69	**.81**	**.84**	.83	.91	**.94**
Mode captivity	**.91**	.18	.15	**.93**	**.93**	.14
Trip rate	.39	**.40**	.40	**.45**	**.45**	.31
Satisfaction	.52	**.68**	**.71**	.65	.57	**.67**
Comfort	.57	**.73**	**.68**	.61	.55	**.68**

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